highest degree of beauty, neither quality at all interfering with the other. We further learn that humble buildings should be simple and subordinate to, but not irrespective of, the more noble; that these should exhibit order and symmetry, but should differ among themselves in Character; efficiency rather than beauty to be looked for in absolutely concealed construction, but ugliness scarcely to be tolerated under any circumstances in features exposed to the eye. The mere rule "Decorate the useful," although good as far as it goes, is inadequate, for the beauty should be a function of the use, and the use of the beauty.

The Lecturer proceeded to inquire in what Styles of Architecture are found the best illustrations of the application of Scientific principles to æsthetic ends, —*i. e.* for the elaboration of beautiful form: observing with reference to the conventional rules which form the grammar (as it were) of each particular style, that these rules were subordinate to principles founded on science and common sense;—that their object was to prevent confusion and ignorant caprice, and were made for the use of the architect and not for his embarrassment.

The Architecture of Greece alone exhibits satisfactory evidences of the application of Science to Fine Art. The Romans actually gloried in the abnegation of the highest aims of art, and no peculiar refinements were to be found in their Architecture, even after the most diligent examination. The Architecture of the thirteenth century, with all its beauties, is so overrun with curious fancies, whether arising from carelessness or symbolism, that the abnormal varieties, which in Greek Architecture point out a principle, are in this style, in the majority of instances, mere caprice, as far at least as art is concerned.

Alberti and Brunelleschi, and the great masters who revived classical art, who so wonderfully succeeded in adapting an ancient Architecture to the uses of their day, and who formed out of it a living style unshackled by timid retrospection, do not seem to have used any peculiar refinements; neither do their chief followers in this country, Inigo Jones and Sir Christopher Wren. Palladian Architecture having fallen into feeble hands was, in this country, ejected by an ill-digested importation of Greek Architecture, to which it did not do justice, either in respect of artistic or of scientific treatment; but it chiefly failed from overlooking the proper use to which the Architecture of the Greek temple should be applied by us.

"It should be proposed as a standard of excellence, as an abstract model for our guidance, and not as one suitable for direct imitation."

The Architecture now in fashion is treated in a manner scarcely less retrospective than the last mentioned, and great as are its intrinsic excellencies, is peculiarly unplastic and opposes itself to the exhibition of mechanical power or scientific refinement.

The late attempts to revive Greek Architecture were much hampered by a feeling of the necessity of carrying symmetry to an extreme which is not found in the original.

A natural type of the picturesque Gothic Architecture may be found in the varied landscape, and of the Greek, in the symmetries of the animal creation; but as in Nature animals, abstractedly symmetrical, are thrown into varied postures and groups, so the Greek Architect used the principle of *asymmetria* in his ichnography; that is, in his ground plan he avoided placing one building directly before another, and turned the lines of those which were independent of each other to different points of the compass, — thus obtaining variety in perspective, fine gradations of light and shade, and an expression of individual character among the buildings themselves. This principle was illustrated by a plan of the Acropolis of Athens.

In this irregular oblong figure, extending from West to East, the point fixed by the nature of the ground, is the Western Entrance where the Propylæa stand. The Parthenon placed near the centre and highest portion of the area, but towards the Southern edge of the rock, is so turned as to offer an angular view from the Propylæa. The latter building being dependent on the Parthenon, its lines are built parallel to those of that temple, and so serve by repetition to increase the effect of the principal object; especially in the general views from the West, when the Parthenon is seen above the Propylæa. At the same time their axes do not coincide, but that of the Propylæa falls altogether to the North of the Parthenon. The Erechtheum, the building of second importance, is placed a little North of the axis of the Propylæa, and is turned obliquely with respect to it, at such an angle as to show its South side distinctly. The colossal statue of Minerva Promachus, stood Eastwards of the Propylæa, and nearly in the direction of its axis, at a distance of about 120 ft. The pedestal of this statue again was placed somewhat obliquely, and there are several platforms at different points and at various levels, which served (there is little doubt) as foundations for small temples, which converge towards the statue of Minerva Promachus, thus producing every variety of angle. And lastly, the small temple of Nike Apteros on the platform of the Propylæa, and to the West, is placed at an angle differing by 18° from parallelism with it.

The Erechtheum, a small building, and the Propylæa are complex in their forms, but the Parthenon (neglecting minute variations) is rigidly symmetrical. In large buildings the effect of perspective introduces sufficient variety. One of the greatest sources of pleasure in Architecture, is the act of reconstructing mentally the real form from an image modified by perspective. That this may be possible — the square and rectangles simply related to it, and the circle should predominate in the ground plan, however much it may be desirable to use more varied parallelograms, the ellipse, or figures of greater variety in the Elevation, which may be seen from the proper point of view almost unaffected by perspective.

The Greek Doric temple is the one form of building ancient or modern which can be pronounced, humanly speaking, perfect. This perfection resulted from the concentrated efforts of several ages. Not by introducing violent changes after each experiment, and so throwing aside all advantage to be derived from them, but by continually improving them by the application of a scientific and refined criticism.

The early temple consisted of an oblong cella, the shrine of the god, surrounded by a Peristyle, or colonnade, usually leaving an ambulatory all round the cella. This composition was covered by a single roof from end to end, with a triangular pediment, or flat gable end, at each extremity. In the latest and most complete examples we find the simple general form preserved, but combined with a highly organized construction. The most important peculiarities are these. The contours of all the columns are delicate curves. The axes of the columns, with scarcely an exception, inclined inwards towards the temple, and the horizontal lines have a slight curvature.

The process of refinement would seem to be as follows: —

The analogy of nature in all bodies which are employed to exert force or pressure at a distance from their attachment to a fixed point, would soon suggest the practice of making the columns taper. The earliest builders would indeed find this done to their hands in the trunks of trees, which found a place in the supports of the hut, more or less the archetype of the Greek temple. It would then be observed that a column built with straight sides, *i.e.* tapering as the frustum of a cone, would appear attenuated or drawn in in the middle — owing to the eye not judging of the form absolutely as an instrument, but bringing into the calculation certain feelings derived from contrast, which make the apparent differ from the real form.

The causes which lead to this apparent attenuation seem to be chiefly these: —

There is some reason for imagining that a frustum of a very sharp cone will under any circumstances appear formed of concave instead of straight sides, but this effect, if it take place at all, will be very slight: other causes however affecting such a frustum when used as a column are more influential.

The eye will rest longer upon the top and bottom of the shafts than on any intermediate points, and this relative importance possessed by those situations will make the intermediate diameters appear too small, when compared with the two extremities of the shaft.

This effect will be further increased by inequalities of chiaro-oscuro. For the relative excess of light on the upper part, owing to the deep back ground of shade under the Portico, and the actual excess on the base owing to the greater amount of reflected light, will throw the balance of light in favour of the extremities, and according to a principle familiar to observers of Nature the brighter parts will appear broader on that account. Among the most obvious illustrations of this phenomenon are the apparent disc of a fixed star; the magnified appearance of a distant candle; the sudden appearance of dilation in the disc of the moon when issuing from a fleecy cloud, or its opposite appearance of stooping on entering it, so poetically described by Milton. From all these, and possibly other causes united, the tapering shaft of the column will appear attenuated, unless its contour be made just so much convex, as to counterbalance these optical illusions. This entasis as it is called, literally *bow-stretching*, as applied in the columns of the Parthenon is formed by an accurate hyperbolic curve, which increases the diameters a little below the middle by the amount of .114 ft. in a shaft 31.4 ft. long. The directions of the axes of this hyperbola are vertical and horizontal; the constant number which expresses the eccentricity is 30; and the principal axis one Greek foot; the vertex does not occur in the shaft and is just two diameters of the column below the base.

The columns of the Propylæa are also hyperbolic, but differ from the last mentioned, in that the vertex of the hyperbola occurs near the middle.

When this difference had been pointed out by measurement, the variation of character resulting therefrom to the two columns became appreciable; but in all the Athenian examples the entasis is so slight, that the first investigators of the remains of Greek architecture, whose eyes were accustomed to the palpable bulging of the columns built by the architects of the 16th and 17th centuries, were deceived by its delicacy, and reported that the Greek columns had no entasis.

Table of Entasis of different columns at Athens.

	Actual measurement in Feet.	In terms of length of Shaft.
Erechtheum	.0195	$\frac{1}{1080}$
Theseum	.023	$\frac{1}{708}$
Parthenon	.057	$\frac{1}{552}$
Propylæa		
Small order	.0343	$\frac{1}{500}$
Large order	.0627	$\frac{1}{400}$

The entasis being established, a second process of refinement would lead to the inclination of the axes of the columns.

The diminution is so entirely in conformity with Nature, that the artifice more or less escapes observation, and the upper diameter does not appear so much smaller than the lower as it really is. This circumstance may combine with the others before mentioned, to demand the entasis, but it immediately produces the effect which the inclination of the columns seeks to remedy. For by how much so ever the sum of the upper diameters is apparently increased, by so much is the appearance of length in the architrave greater than in the stylobate (or step on which the columns stand), and the columns appear to have a fan-like divergence from the base line, unless the length of the architrave be reduced. This was effected by the Greeks by contracting the distance between the capitals of the extreme intercolumniations. This contraction in the Parthenon produces an inclination of .228 ft. in the angle columns in each direction, entailing a parallel inclination inwards in all the intermediate columns of each colonnade. Several subordinate inclinations in the other vertical lines are exhibited in the following table taken from the Parthenon, and the other Athenian examples are more or less analogous.

Columns	inwards	1	in	150
Walls	do.	1	in	80
Face of Tympanum . .	do.	1	in	100
Antæ	forwards	1	in	80
Faces of Cornice . . .	do	1	in	100
Faces of Acroteria . .	do.	1	in	20

The horizontal lines when absolutely straight appeared sunk in the middle. In the great temple at Pæstum, the convexity which is intended to obviate this effect is only found in the fronts; and in the Propylæa at Athens, where the continuity of the stylobate is interrupted, the curvature is only found in the entablature, the centre columns being longer than those towards the angles; thus pointing to the influence of the raking lines of the pediment as the origin of this optical illusion. The curvature of the stylobate and of the flanks followed from the generalization of this idea. This tendency of the eye to be deceived by the contrast of lines, was illustrated by the following experiments: —

A drawing having been prepared of two columns placed side by side, the shafts of which were formed with perfectly straight lines, on each side of these, and from top to bottom, the lecturer drew a flat circular arc, convex to the outline of one of the columns, and concave to the other. The column placed between the two concave lines instantly seemed attenuated, whilst in the other, about which the convex lines were drawn, the effect of a palpable entasis was produced. An outline of a pediment had also been provided, consisting of the horizontal cornice and the two inclined roof lines. The cornice was at first alone visible, and appeared perfectly straight, as it really was, but when the raking lines of the pediments which had been concealed were shown in combination, it appeared to sink in the centre. Lastly an elevation of the front of the Parthenon drawn to a scale of one-twentieth of the full size, from exact measurements obtained at Athens, was exhibited. The line of the cornice, really curved, appeared to be straight, owing to the contrast of the inclined lines of the pediment, until a string was strained from end to end, when the curvature became evident.

The lecturer proceeded to describe some of the smaller details of the architecture, in which many instances of geometrical science are to be found.

The parabola and hyperbola selected with the parameters at the vertex, small in comparison with the length of the arc employed, were used in almost all cases where great variety of curvature was sought. There were even some indications of a knowledge of the determination of the radius of curvature in a Conic Section.

A moulding of circular section was used in the Parthenon only in the crowning member or Cymatium.

It was observed that lines of determinate varied curvature were preferable to those arbitrarily drawn, and still more to patched combinations of the arcs of different circles, in which each circle seemed always struggling to express its own curvature, and discordant with the sequence of the general line.

In conclusion the lecturer said that the object of the architect should be to study what the Greeks and other real advancers of art achieved, and to extend their principles by embodying as much as possible the science of the day.

It was not the curved lines or the use of the Conic Sections in the mouldings which produced their excellence, but because they pursued art in the right way; they availed themselves of whatever methods would obviate the optical illusions which impaired the beauty of their architecture, and of whatever geometrical figures would in the most simple manner give them the determinate varied curves in which they delighted.

Several instruments for drawing curves by continued motion invented by the Lecturer also were exhibited: one for drawing the hyperbola by means of a variable triangle, with a constant base sliding on the asymptotes of the curve. (The same instrument would also draw the conchoid of Nicomedes.) An instrument on the principle of a skeleton cone for drawing all the conic sections — and an instrument for drawing the Cissoid of Diocles, with variations of that curve; Penrose and Bennett's registered Helicograph for drawing all the varieties of the equiangular spiral from the circle to the straight line. A specimen of its operation was shewn in a drawing of an Ionic capital, after the Erechtheum; and a simple instrument invented by Mr. Jopling for drawing a fine wave, or line of beauty, by means of the curve *lemniscata,* and an oblique elliptic trammel, made from a pattern proposed by the same inventor. [F. C. P.]

In the Library were exhibited: —

Instruments used in Measuring the Parthenon; and Sketches of Athens, &c. by Mr. F. C. Penrose.

"The Principles of Athenian Architecture, by F. C. Penrose, Esq." Presented by the Society of Dilettanti.

Talbotype Views of the Parthenon, Athens, &c. by Messrs. Henneman and Co.

Geometric Curves and Apparatus used in drawing them, with description by Mr. Joseph Jopling. [See "An Impulse to Art; and Examples of Entasis," &c. 8vo. 1849, by Mr. Jopling, presented by him to the Library, R. I.]

Specimens of Glass Mosaic, by Mr. G. H. Stevens.

Models of Smoke-Consuming Furnaces, &c. by Messrs. Juckes, Addams, and Coupland.

Model of Galloway's Tubular Boiler. [Exhibited by Mr. Armstrong.]

Sepulchral Seals and other Antiquities, from the United Service Institution.

A Painting on Marble, by Paul Brill. [Exhibited by Mr. H. Brooke.]

Dies and Medals, by Mr. G. Barclay.